Final Report

Specific Cooperative Agreement No. 58-51913-838
"Quantifying factors influencing forage utilization by dairy cattle".

Introduction

Forage utilization is affected by several factors. Some have to do with animal utilization and some are due to characteristics inherent in the forage. Utilization by animals involves such things as rate of feed intake, rumen feed turnover rate, rate and extent of digestibility, and phenomena related to the utilization of nutrients after digestion. One dietary component may react with another in non-additive fashion on any of the functions mentioned. Of primary interest is quantitating relationships between variation in forage composition and variation in animal utilization and productivity or parts of that complex phenomenon.

Methodology

Forage composition varies for several reasons one of which is forage species. Legumes and grasses differ considerably in composition and it was important to relate these differences to animal utilization factors. Hay from pure stands of alfalfa and brome (smooth bromegrass) were produced, analyzed and fed to dairy cattle and sheep in several feeding trials to gain a better understanding of the relation between forage composition and animal utilization and production. The results of several trials and laboratory analyses of these hays will be examined and discussed.

Results

Comparison of brome and alfalfa hays fed to yearling Holstein heifers.

Alfalfa and brome hays were fed in ratios of 100:0, 75:25, 50:50, 25:75 and 0:100 of alfalfa:brome. These diets ranged in CP from 15.1 to 19.8%, in CF from 26.8 to 33.2%, in NDF from 53.5 to 63.2%, in ADF from 31.7 to 39.8% and in ADL from 3.7 to 8.4% without affecting growth rate, feed intake, rumen fill or

rumen DM turnover rate. Another group was fed brome hay that contained 14.0% CP, 33.1% CF, 73.8% NDF, 39.4% ADF and 4.6% ADL. This group ate less, grew more slowly, had more rumen fill and a slower turnover of rumen DM. The one constituent that was out of the range of the other hays was NDF, indicating that at that high concentration it limited production.

Effect of mixing alfalfa and brome hays on intake and digestibility.

Alfalfa and brome hays similar to those fed to heifers were fed to sheep in three combinations 1) alfalfa, 2) 50% alfalfa and 50% brome and 3) brome. The mixture was consumed in smaller quantities than either hay indicating the possibility of a small negative associative effect. The mixture showed no associative effect on digestibility of hay constituents. Neither acid detergent lignin nor acid insoluble ash proved effective as a marker in determining digestibility coefficients.

Factors affecting neutral detergent fiber and acid detergent fiber analyses of alfalfa and brome hays.

Hay samples from the heifer feeding trial were analyzed independently by four analysts. One analyst used conventional equipment while the other three used "automatic" equipment. One analyst expressed values as ash free portions of dry matter. ADF values determined independently were compared to values determined sequentially after NDF. Repeatability of analytical results varied considerably among analysts and probably was related to experience. Results for NDF varied among analysts but ADF did not. Expressing values on an ash free base did not affect alfalfa values but decreased values for brome about 2%. ADF values were reduced about 1.5 for alfalfa and .6 percentage units by sequencial analysis.

Effect of sampling procedure on chemical analyses of alfalfa and brome hays.

Baled hay was core drilled before shredding it in a "bale buster".

Multiple grab samples of shredded hay and composited samples from the core were analyzed simultaneously. Core samples contained more protein and less fiber. Alfalfa was more affected than brome by shredding. When baled hay is chopped or broken down physically, the forage presented to the animal has most likely been changed in energy and protein content from the baled hay. What is fed is what should be analyzed.

Evaluating a proposed hay grading system.

Groups of Holstein heifers were fed diets that consisted mainly of alfalfa or brome hays but that were in certain instances supplemented with small amounts of concentrates to increase the diets energy contents. Dietary energy needs of the heifers consuming these diets were derived from the 1978 dairy cattle feeding standard of the NRC based on body weights and rates of gain. Diets were evaluated by chemical analysis and application of formulas that estimated intake from NDF and digestibility from ADF values. Intake of DE (digestible energy) was calculated from intake of DM and its digestibility. By comparing estimates of DE intake with DE required (DE intake/DE required) it was found that estimated DE intake was about 26% above requirement. In other words, all hays were over evaluated by about 26%. An examination of the data indicated that alfalfa rations were overevaluated mostly by an overestimation of intake while the brome diets were overestimated more by overestimating digestibility. Each forage species had its own set of formulas thereby posing a problem for mixed legume-grass hays. Formulas for legumes and grass estimated similar digestibilities of the rations tested but intake differed quite widely in some but not all rations.

Mean milk production of Holstein cattle fed either alfalfa or brome hay supplemented with 40, 50 or 60% concentrate.

The hays were similar to hays used in previous experiments. Both contained approximately 20% CP. Milk production is illustrated in the following table.

	Alfalfa			Smooth Bromegrass		
Concentrate	No. of cows	Milk	FCM[a]	No. of cows	Milk	FCM
% of DM		-- kg/da --			--- kg/da ---	
40	20	28.7	26.6	20	29.3	27.1
50	22	29.8	27.6	18	31.1	28.9
60	20	30.8	27.6	18	31.6	29.7
$\bar{x}$		29.8	27.3		30.6	28.7

[a] 4.0% fat-corrected milk.

As more concentrate was fed more milk or FCM was produced. Milk fat content was reduced by high grain use with alfalfa but milk fat content was not reduced when high-grain was used with brome hay. Intake data have not been summarized. It is clear that good quality brome hay supports milk production equally as well as high quality alfalfa and may have advantages where forage intake is limited.

Formulas to predict the available energy content of dietary dry matter fed to milking cows.

Two formulas from the literature were evaluated for how well they estimated TDN values of practical dairy cattle rations from ration CF. Dietary CF content affected the reliability of predicting energy content in a linear manner. Corrections were derived. Formula was derived to predict TDN from ADF. Finally derived formulas are as follows:

TDN (g/kg DM)

1) = (902.5 - 1.175 g CF/kg DM)/(1.3 - .00116 g CF/kg DM)

2) = (787 - .802 g CF/kg DM)/(1.12 - .00057 g CF/kg DM)

3) = (923 - 1.083 g ADF/kg DM)/(1.32 - .00108 g ADF/kg DM)

Energy contents of practical dairy cattle rations were estimated by use of the first two formulas for seven rations used in two herds in which ration CF and intake of DM were known. Calculated TDN intake was within 1.0% of energy requirements derived from use of Nutrient Requirements of Dairy Cattle (NRC 1978) in each of the seven instances.

General Discussion

Forage fiber affects quality in two ways. Because fiber is bulky, it may limit feed intake and in this manner restrict animal productivity. The second way fiber affects forage quality is through its negative relation to digestibility. As fiber increases in forage so does its lignification. As lignification increases the extent of dry matter digestion decreases. Lignin is not a good indicator of quality except on a within species basis. Legumes are inherently higher in lignin but at any given level of lignin, legumes contain more available energy than grasses. When one relates fiber to quality the question arises as to which fiber portion or kind one is refering to. There are three "fibers" in more or less common use - 1) CF (crude fiber), 2) NDF (neutral detergent fiber) and 3) ADF (acid detergent fiber). The relationships between these fractions in forage (and complete rations other than forage) have been studied extensively. Intake of digestible energy is directly related to animal utilization and production. It is not yet clear as to how one can best estimate intake of DE of a forage, from its composition.

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December 30, 1983

Dr. R. J. Bula, Director
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USDA-ARS
1925 Linden Drive West
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Dear Ray:

Enclosed is a termination report for the first cooperative agreement between USDA-ARS and the Dairy Science Department, University of Missouri - Columbia. The approach I have used is rather intensive and basic, because I am not sure who, besides the immediate USDA-ARS personnel, might be reviewing it. There was a lot of methodological development, as documented. I have gone into depths regarding this because it was time-consuming and because it was a major objective. There are some animal data that have been determined and summarized but really belong more under the second agreement. There currently is a trial in progress relating to labeled mineral that probably relates to the first agreement; however, because it has taken so long to get to this point, it will be reported under the second agreement. When we have more data available and summarized, I plan to begin writing manuscripts for publication; I hope to get several printed eventually. We will have a lot of base data on mineral availability.

These agreements have been of incalculable value to our program and our professional endeavors. I can't begin to express our appreciation to you in particular and to USDA-ARS in general for your support. This cluster program will be a very productive and successful one.

Sincerely,

Ronald Belyea

Ronald L. Belyea
Associate Professor

mlf

December 30, 1981

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U.S. Dairy Forage Research Center
USDA-ARS
1925 Linden Drive West
University of Wisconsin
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